Cricket Pitches – Science behind the Art of Pitch Making

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Abstract

It is an old proverb that cricket pitch making is an art which has been transformed from one generation of Groundsman to another since the inception of the game of cricket in India by the British colonial rulers. Each steps and available conditions during the pitch making process either from pitch soil selection, laboratory testing, its layering process and technique, and acclimatized grass selection and planting, rolling techniques and schedules to attain the maximum compaction, effect of micro- climatic meteorological factors (such as temperature, relative humidity, available soil moisture within the pitch profile, wind speed, Evapo - Transpiration rate, Dew factors and available soil moisture just above and below the pitch surface etc., does have the proved scientific reasons and have the direct correlation with the desired outcome and performance of the pitch. Nearly a century old traditional and conventional style of pitch soil selection and its layering concepts based only on the skill based on trial and error of the groundsman lacking the desired scientific know how and reasons of making a good pitch should be improved. Today by the initiation of the BCCI along with the associated State Cricket Associations a special campaign has been taken to find out the gap between the traditional style of pitch making process vs. the different scientific methods based on research and developments. Nearly, most of the pitch soils used by the major cricket stadiums of India have been analyzed on physical and chemical parameters by IIT Powai by the BCCI. The above mentioned physical and chemical analysis report will help to understand the vast variability and its behavior of important pitches of India under different climatic variability and zones. Synergetic efforts of the BCCI along with the associated State Cricket Associations and the Central and State Agricultural / Engineering colleges may produce magical results regarding the nature and behavior of great Indian pitches. This review article is an effort to understand the various scientific logics and reasons (based on research and developments) of pitch making process by taking advantage of the skills and experience gathered by the curators and groundsman over a period of time.

Keywords – *BCCI, ICC, Optimum Moisture Content,*

Introduction-

According to the ICC operating manual (29.1) – "ICC acknowledges the skills and complexities involved in the preparation of pitches. It is understood that conditions may vary considerably from country to country, venue to venue and even from match to match depending upon prevailing weather conditions and that this will have an impact on the nature of pitches produced. ICC recognizes these variations as part of the unique nature of sport."

It is said that a good quality of international cricket can only be played only on standardized good quality pith only. A good cricket pitch should provide a keen contest between bat and a ball. It should have a good pace, consistent bounce, good ball carry and conducive for stroke play. Above all it should be result oriented and at no time the pitch should become unplayable or dangerous for the batsman.

An ideal Test Match pitch should have the following characteristics –

"All pitches will be judged solely on how they play. The objective shall be to provide a balanced contest between Bat and Ball over the course of the match, allowing all the individual skill of the game to be demonstrated by the players at various stages of the match." According to the ICC operating manual

For a four or five day game –

Day 1: The pitch should be quite moist, with some green grass on the surface. A green surface will allow the ball to seam around a bit. The pitch should have consistent pace and bounce.

Days 2 & 3: The pitch will have dried out and should become more bouncy and it should quicken up (provided it does not crack badly by becoming too dry too quickly). It will have lost its greenness and so should not seam around much. The ball should come nicely onto the bat and the pitch should now be ideal for batting.

Day 4: The surface should start to powder and the cracks will start to open up. This will slow the pitch down. It will become less bouncy, the bounce will become more inconsistent and it will start to take spin.

Day 5: The above pattern will be accentuated as the pitch wears further.

For a one day limited- over's or T 20 games

"The objective shall be to provide a pitch that is favorable to good shot making and, most importantly, performs in a consistent manner throughout the course of the match so as to provide a fair contest to both teams."

According to the ICC operating manual

The general requirement here is for a pitch which will favor the batsmen. The ideal would be to produce a pitch equivalent to that on the second or third day of a five day game. This suggests that water should be withheld for one to two days longer than for a five day game to allow it to dry out for a day or two longer.

Materials and Methods

For the purpose of in depth study the contents have been taken from the relevant books, research articles, journals, and websites. The method is analytical and descriptive in which both the primary and secondary sources of information have been taken.

Results and Discussions.

All the three above mentioned formats of cricket are played on the same pitch soil but why the results differ. It is not only the good quality clay soil with high percentage of clay contents but the type of clay minerals (either 1:1 or 2: 1 Kaolinite, Illite, Vermiculite or Smectite) is much important. Even with less percentage of clay % (as in Australia) but with Smectite type of clay produces a good bouncy and fast pitches as compared to pitches having non- expanding or less expanding lattice structure like the Illite or Kaolinite type of clay minerals. High level of clay % with smectite or vermiculite type of clay minerals is the DNA of any cricket pitches which defines its nature and behavior.

Rolling the above mentioned pitch soil with good and uniform grass binding at the calculated Optimum Moisture Content with different planned schedules produces entirely magical results. Every pitch soil can be compacted and consolidated and compacted at different Optimum Moisture Content only which has to be examined by experience and only through adopting scientific methods (CBR – California Bearing Ratio or Modified Proctor Test) only.

Uniform deep rooted grass growth is one of the major reasons of having a fast and bouncy wicket as it helps in deep drying by the help of transpiration and by providing a firm structure to the pitch soil. It acts as a skeleton of a pitch which provides a firm shape and structure to it. As in human beings skeleton along with the muscles provides a definite shape to the body the same analog is applicable to the pitches also in which the pitch soil acts as a muscles and the deep rooted grass acts as skeleton and provides a definite and firm shape and structure the pitch profile.

The above mentioned ideal characteristics desired in all different available forms of cricket can only be achieved by -

1- Having a pitch soil with high clay % preferably the Smectite or Vermiculite,

2- Achieving the maximum bulk density (compaction and consolidation) of the pitch by rolling with proper roller weight and schedule at the calculated Optimum Moisture Content ,

3- Having deep rooted uniform grass cover throughout the pitch profile.

This can only be achieved by adopting the scientific ways based on the recent research and developments which can bring entirely different results in-spite of having the same pitch with same microclimate (Temperature, Relative Humidity, Evapo-transpiration Rate , Wind speed and available suspended air moisture in the form of Fog, Mist or Due) and macro-climatic and weather conditions. The conventional or traditional mind-set and style of making pitches without having a scientific logic and reasons should be changed as there is always a science behind the art

of pitch making. Nearly, total cost of laying a new multiple pitches and outfield (drainage system and modern irrigation facilities also) with scientifically approved layers comes out to be 1 to 2 % of the total project cost.

Newly laid pitches and outfield have nearly 10-15 years of economic life during which they provide results of International standards. Its life is restricted due to accumulation of the dead organic matter and humus pitch grasses which gradually reduces the clay % present in the pitch profile. Further different layers occur in the pitch profile due to use of different pitch soil as used in the initial stages and due to faulty rolling schedules. Heavy salt accumulation is there in the pitch layer thereby effecting the pH level and affecting the nature and behavior of the pitches.

Secondly, the clay soil used for pitch laying and sandy loam and sand for laying the drainage layer and the outfield layer is becoming scarce, expensive and is treated as a mineral resource by most of the states in India. So, these materials should be used judiciously and according to the prescribed layers only.

Undesired multiple layer of surface (not more than 300 mm) and sub surface layer (nearly 8-10 inches only) will only add to increase the project cost. Relaying or renovating the pitch and outfield due to un-scientific ways of its laying and its maintenance will only provide a different undesired behavior and will have additional recurring cost to the project.

For achieving the above mentioned ideal conditions in different levels of cricket the cricket pitch soil should have the following important characteristics –

1 - Have a Plasticity which allows remolding and compaction by rolling, thus giving a smooth surface,

2 – Have a deeply dried hard surface so that the elasticity of the ball is manifested, and preferably one that at some stage allows turn of the ball, (a hard clay surface is itself elastic). In other words an elastic surface will provide good bounce for the fast bowlers and turn for the spinners,

3 – Have soil cohesion that provides vertical stability preventing differential change in elevation of parts of the surface, lifting out of crumbling or powdering. There should not break at depth causing plating, or the surface to flake.

4 – Have an ability to recover from the compaction of preparation, so that the soil structure and the Bermuda grass can regenerate. The soil must be cracking clay. When the soil cracks it de compacts itself and allows air and water to enter the root zone of the grass, thus rejuvenating both the soil and the grass.

5 - Should not crack excessively (crumble) nor have excessively wide cracks.

6 – Should have a sufficiently high permeability when wet, to ensure reasonable rates of water movement and leaching of salts. Different clays have rate of hydraulic conductivity (rate at which water moves through the soil), and a suitable soil has to have a reasonable hydraulic conductivity so that the water can move slowly right through the profile, and move salts with it.

7 – Should have a means of removal of excess water so that aeration occurs, as well as the removal of salts through the drainage layer lying beneath. There needs to be a permeable layer directly under the clay soil to allow excess water and salts to drain out of the wicket soil into it.

8 – Should have a completely uniform grass cover, preferably with Couch grass prior to the final preparation, with uniformity of root penetration to an appreciable depth (at least 100 mm) .This is essential to give uniform moisture levels and rates of drying of the surface and top 100 mm.

9 – Should be rich in nutrients, available essential minerals and humus basically in colloidal state.

In summary the above mentioned ideal standards can only be found in the pitch soil which has plasticity for rolling, a smooth and hard surface after rolling, regulated cracks, has a good drainage rate (hydraulic conductivity) , and recovers from the compaction of preparation to allow good grass growth.

The above mentioned ideal conditions desired by the ICC or the BCCI at the international level can only be achieved by having a scientific ways of selection of good pitch soil by analyzing its physical, chemical, mineralogical and engineering properties over the long ways of traditional style of making pitches in India which is generally based on permutations and combinations and the skills transformed from one generation of grounds man to another. Based on the scientific research and developments the desirable Physical, Chemical, Mechanical and Mineralogical examinations to get the above mentioned results are as follows-

A Physical analysis - Particle size analysis for soil texture, Crushing Strength, Cracking pattern, linear shrinkage, Emersion and Dispersion Index.

B Chemical analysis – Chloride, Sodium, Potassium, Calcium, Magnesium and its ratio, Ph in water and cacl2 , Cation Exchange Capacity, EC total salts , ESP- Exchangeable Sodium percentage , % Organic Matter in oven dried soils, CaCo3 – Calcium carbonate (The difference Between the Sodium, Potassium, Calcium, Magnesium and the CEC Gives the Hydrogen ion concentration).

C Mineralogical analysis - X- RAY DIFFRACTION method to determine the Structure and type Of Clay minerals either Kaolinite, Illite, Smectite or Vermiculite having 1:1 or 2:1 structure.

D Engineering Properties – Atterberg limits, Soil strength, compatibility, penetrability, through Procter or modified Procter test, Shear strength (traffic- ability) or CBR – California Bearing Ratio.

	Scope of the above mentioned analysis reports are as follows-		
	Properties	Desirable Values	Reasons

A	Physical properties		
	Soil Texture		
	Clay (< .002 mm)	50- 70%	Have high plasticity, elasticity, high water holding capacity, high compaction level, de-compacts and grass growth and post match recovery is fast.
	Silt (.002- .02 mm)	5-20 %	
	Sand- Fine (.02- .25mm)	10-20 %	
	Medium (.25- 1.00 mm)	0-10 %	
	Coarse (1. -2.0 mm)	1%	
	Crushing Strength	0.8- 1.6 - MPA	to analyze the soil cohesion or strength to
			With stand the ball impact.
	Cracking Pattern	2-5 pcs desirable	the width and number of cracks is essential
		6-10pcs acceptable	for good grass growth and after match
		> 11 Not acceptable	recovery and reconsolidation.
	Linear Shrinkage	8- 15 %	to analyze physically about the nature and
	(COLE- Coefficient -		type of clay having shrinking and swelling
	Of Linear Shrinkage)		Capacities.
		Value 6	to analyze physically about the dispersibility

	Emersion Test	desirable	
			of the pitch soil.
	Dispersion Index	Value 8 desirable	
	Free Swell Index	< 50 %	Are commonly used for identifying expansive clays and to predict the swelling potential.
	Expansion 0-20 21-50 51-90 91-130 130	Potential Very low Low Medium High Very high	
B	Chemical Analysis		
	Sodium level	< 5 me %	High Na level reduces the Hydraulic Conductivity
			leading to more dispersion which causes pores
			to be blocked by migrating particles.
	CEC EC		

	Na ,Ca, Mg, K Ca+ / Mg+ Ratio ESP < 3-5		
			Hydraulic conductivity decreases with increase in ESP.
	PH	6-7 in water and	regulates the available nutrients and micro-
		5-6 in CaCl2	nutrients in the soil also affects the swelling
			Capacity of clay minerals.
		< 0.15	above causes the soil crumbling.
	CaCo3 or MgCo3	< 1%	above causes the soil mulching.
	Organic Matter	< 5 %	
D	Engineering Properties		
	Atterberg Limit		For Soil classification based on Liquid (LL), Plastic)PL), Shrinkage limit and Plasticity Index(PI) PI is measure of plasticity of soil. It is the size of the range of water contents

			where the soil exhibits the plastic properties.
		PI Range 0-3 3-15 15-30 >30	Plasticity Behavior Non Plastic Slightly plastic Medium plastic Highly plastic.
	Clegg Hammer Test		to test the compaction level or surface hardness
		(207-424) g	Average readings
		< 200 g	Slow Pitch.
		(200-350)	Medium Fast Pitch.
		> 350 g	Fast Pitch.
E	Mineralogical Properties		To analyze the structure and clay minerals type
	(through X-Ray		either Kaolinite, Illite, Smectite or Vermiculite
	Diffraction)		with 1:1 or 2:1 structure.

Statement of Problem

	Name of the Stadium	Test match played	ODI played	T 20 played	First match played	Last match played
1	Roop Singh Stadium, Gwalior, Madhya Pradesh	0	12	0	22-Jan-88	24-Feb-10
2	Rajiv Gandhi International Cricket Stadium, Hyderabad, Andhra Pradesh	3	4	0	16-Nov-05	02-Mar-13
3	PCA Stadium, Mohali, Punjab	11	21	1	22-Nov-93	14-Mar-13
4	Nehru Stadium, Indore, Madhya Pradesh	0	9	0	01-Dec-83	31-Mar-01
5	Nehru Stadium, Guwahati, Assam	0	16	0	17-Dec-83	28-Nov-10
6	Moin-ul-Haq Stadium, Patna, Bihar	0	2	0	15-Nov-93	27-Feb-96
7	M. Chinnaswamy Stadium, Bangalore, Karnataka	20	23	1	22-Nov-74	25-Dec-12
8	M. A. Chidambaram Stadium, Chennai, Tamil Nadu	31	20	1	10-Feb-34	22-Feb-13

9	Lal Bahadur Shastri Stadium ,Hyderabad, Andhra Pradesh	3	14	0	19-Nov-55	15-Nov-03
10	Keenan Stadium, Jamshedpur, Jharkhand	0	10	0	07-Dec-83	12-Apr-06
11	JSCA International Cricket Stadium Ranchi, Jharkhand,	0	2	6	19-Jan-13	23-Oct-13
12	Jawaharlal Nehru Stadium, Kochi, Kerala	0	8	0	01-Apr-98	15-Jan-13
13	Indira Priyadarshini Stadium, Visakhapatnam, Andhra Pradesh	0	5	0	10-Dec-88	03-Apr-01
14	HPCA Stadium, Dharamsala, Himachal Pradesh	0	1	0	27-Jan-13	27-Jan-13
15	Holkar Cricket Stadium, Indore, Madhya Pradesh	0	3	0	15-Apr-06	08-Dec-11
16	Green Park Stadium, Kanpur, Uttar Pradesh	21	12	0	12-Jan-52	27-Nov-13
17	Feroz Shah Kotla, Delhi	32	23	0	10-Nov-48	22-Mar-13

18	Eden Garden, Kolkata, West Bengal	38	27	1	05-Jan-34	03-Jan-13
19	DY Patil Stadium, Navi Mumbai, Maharashtra	0	1	0	11-Nov-09	11-Nov-09
20	Brabourne Stadium, Mumbai, Maharashtra	18	8	1	09-Dec-48	12-Dec-09
21	Barabati Stadium	2	17	0	27-Jan-82	29-Nov-11

Data Source – Google

Some of the above mentioned important Indian cricket stadiums hosting National and International tournaments since the Independence era are laid on traditional or conventional style with number of multiple layers (even 5 to 7) and without or very poor drainage systems. Recent research and developments proves that 2 or 3 layer wickets are economical and prudent to get the best pitches. Rollers used for compaction has its maximum vertical density only to the depth of 4 inches only. Nearly, only 8 inches of sandy loam and river washed sand (4 inches each) are required to act as a drainage layer only. Thick layer of clay pitch soils more than 300 mm only creates a pitch layering and acts as a source of perched water table only. Excess moisture is retained in this thick layer of pitch soil and affects the nature and behavior of playing surface. Most of the pitches will have to be renovated according to the latest prescribed scientific norms of pitch layering .Even the recently developed stadiums in the last five years have laid down their pitches without examining the mineralogical composition of pitch soils without which the above mentioned objectives of having a good pitch as found in the other playing continents cannot be achieved. The above mentioned ideal conditions desired by the ICC or the BCCI at the international level can only be achieved by having a scientific ways of selection of good pitch soil by analyzing its physical, chemical, mineralogical and engineering properties over the long ways of traditional style of making pitches in India which is generally based on permutations and combinations and the skills transformed from one generation of grounds man to another.

Review of literature

Ekwue, E. I., Lall ,D. Z. and Stone , R. J., - Engineering Properties of Major Soils

Used in Cricket Pitches in Trinidad , West Indies Journal of Engineering Volume 28, No.2, (January 2006) Technical Paper.

The conclusions and inference drawn from the above mentioned article are as follows-

"Ground curators always prepare cricket pitches by feel. Curators depend on their senses to determine.

When a pitch has sufficient water and has been rolled enough to achieve a good result, which includes a durable pitch that allows for good bounce and pace of the ball. Scientific measurements of moisture content, compaction at OMC, infiltration rates and other parameters are not used in preparation of cricket pitches. The need for the detailed study of soil properties used in cricket pitches is very important in order to help in advising curators in their preparation and maintenance of pitches." Apart from physical and chemical properties , soil engineering properties like the compactibility and compressibility at OMC , shear strength and penetration resistance also influences the performance of cricket pitches. The ideal cricket pitch should have- 50-60 % clay , less than 10% coarse sand, less than5 % calcium carbonate and Sodium levels , a linear shrinkage of .08 -.015 and less than 5% organic matter. Presently, the game demands a fair, precise, durable and sometimes predictable pitch in order to achieve a Successful both batsman and bowlers. The above mentioned ideal conditions can only be achieved by performing Mineralogical test (through XRD) to find out the type of clay minerals either highly swelling and shrinking Smectite, Vermiculite or limited or non expanding Kaolinite or Illite lattice structure. Clay mineralogy is the DNA or Genes of any pitch soil which provides the intrinsic template to have all the desired physical, chemical or engineering properties for a good pitch.

Significance of the research

In India, traditional style of pitch making with least concentration on pitch soil sampling and its analysis on physical, chemical, mineralogical and engineering properties before its use in pitch preparation is the general trend. It was done merely on the basis of permutation and combination and skill developed from generations to generations. Even in the process of pitch soil type selection and its layering concepts (either 3, 4, or 5 layered wickets) , deep rooted grass selection and its uniform growth , rolling concepts and its schedule at the optimum moisture content for maximum compaction are directly affected by the type and nature of soil used for preparing a pitch. Countries

like South Africa, England, Australia and New Zealand are having bouncy and fast pitches only as a coordinated effort by the localized cricket associations, Engineering and Agricultural colleges. Their valuable research and development based on the experience and skills of the grounds man and curators either on pitch soil selection, their layering , grass variety selection and maintenance , rolling techniques and patterns , maximum compaction level at the optimum moisture content etc. can only produce fast and bouncy pitches in India at the international arena. In India scientific research and development with the involvement of centralized Agricultural and Engineering universities along with the BCCI and the local state units associations working on individual localized and acclimatizes soil and weather conditions can only bring the face of the dead flat and slow wickets. The broad gap in between the nature and character of Indian pitches with that available in the South Africa, England, Australia and New zealand can only be changed by the coordinated efforts of the above mentioned institutions only. The old traditional, unscientific style of pitch preparation and maintenance process has to be changed which will change the total nature and character of the Indian pitches. As through the process of evolution human kind , the Genes are the basic block which builds the nature and character of humans beings. Soil type and its basic minerals (either illite, kaolinite, montmorillonite or smectite) are the genes of any pitch soils which defines and governs the basic nature and behavior of any pitch. This can only be achieved by having the detailed physical, chemical, mineralogical and engineering property analysis of pitch soil before its final selection and use.

Hypotheses of Study.

1 - It is said that a good quality of international cricket can only be played only on standardized good quality pith only. The above mentioned ideal conditions desired by the ICC or the BCCI at the international level can only be achieved by having a economic and scientific ways of selection of good pitch soil by analyzing its physical, chemical, mineralogical and engineering properties over the long ways of traditional style of making pitches in India which is generally based on

permutations and combinations, trial and error basis and the skills transformed from one generation of grounds man to another.

2 As through the process of evolution human kind , the Genes / the DNA are the basic building block which builds the nature and character of humans beings. Soil type and its basic minerals (either illite, kaolinite, montmorillonite or smectite) are the genes of any pitch soils which defines and governs the economic viability and basic nature and behavior of any pitch. This can only be achieved by having the detailed physical, chemical, mineralogical and engineering property analysis of pitch soil before its final selection and use commercially.

Conclusions-

Previously the above Physical and Chemical analysis of pitch soils were only considered as a litmus test for preliminary acceptance or rejection of the pitch soil samples. Soils with high clay contents with acceptable desired physical and chemical parameters were generally finally accepted as laying down the pitch. But the recent studies suggest that the mineral type present in the clay soil is much more vital than the high percentage of clay content. Pitch soils with very high clay content but with none or less expanding lattice structures such as Illitte or Kaolinite clay minerals are undesirable as a pitch soil. Pitch soils even with low clay percentage but having Smectite or Vermiculite type of clay minerals are mostly desired as a pitch soil.

Smectite or Vermiculite clays are a group of clay minerals that are able to expand and contract in one dimension as they absorb water or dry like a stack of papers that can become taller. The structural layer of these type of clays have a small negative charge therefore, attracts water molecules or other polar into the interlayer area , causing expansion. These water molecules are generally aligned around positively charged ions or cations such as Na+ or Ca+2 (interlayer cations) and next to the layer.

The amount of swelling or shrinking is related to the type of interlayer cations present in the lattice structures. Sodium rich smectite clays expand more than those containing calcium.

Therefore, in modern era of pitch soil selection and analysis of clay mineralogy type Illite, Kaolinite, Vermiculite or Smectite will be considered as a basic preliminary test so as to accept or

reject the soil samples to be finally used as a pitch soil. Soil mineralogy type and the inter layer cations present determines the physical and chemical behavior in the pitch soils. High level of clay % with smectite or vermiculite type of clay minerals is the **DNA** of any cricket pitches which defines its nature and behavior.

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